Research Article

Molecular Interaction in Aqueous Solution of Butanol Isomers at 298.15 K

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ABSTRACT

Viscosity (η) of solutions of 1-butanol, sec-butanol, isobutanol and tert-butanol were investigated in aqueous solution structures of ranged composition from 0.55 to 1 $mol.dm^{-3}$ at 298.15 K. The data of ($\eta/\eta_\circ$) were evaluated based on reduced Jone - Dole equation; $\eta/\eta_\circ$ =BC+1. In the term of B value, the consequences based on solute-solvent interaction in aqueous solutions of alcohols were deliberated.

The outcomes of this paper discloses that alcohols act as structure producers in the water. Additionally, it has shown that solute-solvent with interacting activity of identical magnitude is in water-alcohol system.

Keywords: Alcohols, Solute-solvent interaction, Jone-Dole equation, Viscosity and B-coefficient.

INTRODUCTION

For aqueous solutions of diverse concentrations, viscosities were investigated thoroughly and its data were employed to conclude the existence of molecular interacting in terms of solute-solute, ion-ion as well as solute-solvent in the system [1,2,3]. Theoretically, A and B stand for viscosity parameters that describe solute-solvent and solute-solute interaction in diverse systems. A role of viscosity has gained the attention of several studies in characterizing the molecular interactions in aqueous and non-aqueous solution during the past decade [4-11].

Alcohols are biologically and technologically significant amphiphilic materials that are in the liquid state as a result of hydrogen bonding of their O-H groups. They have been polar and self-associated liquids, employed for the synthesizing other organic compounds. They have been extensively adopted as coupling and dispersing means in the pharmaceutical, chemical and hose hold productions. They can be as carrier and extraction solvents for biological products [12-17].

Solute induced modification in the water structure have been studied by many chemists [18,19].

EXPERIMENTAL

Alcohols were supplied by Aldrich Company with purity of 99%. A viscosity has evaluated based on a controlled suspended-level ubbelohode viscometer to regulate the bath temperature with the accuracy of about ± 0.01 K under 298.15 K to give the absolute magnitudes of viscosity. The empiricists were done, as minimum, three times and then results were corrected. Such variation was also observed in reported values of viscosities in [20].

RESULTS AND DISCUSSIONS

The ($\eta/\eta_\circ$) magnitudes at diverse concentrations of alcohols have been examined and specified in Tables 1,2,3 and 4

Table 1: The $\eta/\eta_\circ$ variation with concentration of 1- butanol at 289.15 K

S.No.	Concentration($mol.dm^{-3}$)	η (cp)	$\eta/\eta_\circ$	√C	($\eta/\eta_\circ$-1)/ √C
1	0.55	0.9839	1.1054	0.7416	0.1421
2	0.60	0.9939	1.1166	0.7746	0.1505
3	0.65	1.0034	1.1273	0.8062	0.1579
4	0.70	1.0136	1.1388	0.8367	0.1658
5	0.75	1.0157	1.1411	0.8660	0.1629
6	0.80	1.0286	1.1556	0.8944	0.1739
7	0.85	1.0489	1.1785	0.9220	0.1936
8	0.90	1.0523	1.1822	0.9487	0.1920
9	0.95	1.0631	1.1944	0.9747	0.1994

10	1.00	1.0697	1.2018	1.0000	0.2018

Table 2: The $\eta/\eta_\circ$ variation with concentration of Sec-butanol at 289.15K

S.No.	Concentration (mol.dm^{-3})	η (cp)	$\eta/\eta_\circ$	√C	$(\eta/\eta_\circ-1)/\sqrt{C}$
1	0.55	0.9967	1.1198	0.7416	0.1615
2	0.60	1.0068	1.1311	0.7746	0.1692
3	0.65	1.0214	1.1475	0.8062	0.1830
4	0.70	1.0392	1.1675	0.8367	0.2002
5	0.75	1.0502	1.1798	0.8660	0.2076
6	0.80	1.0626	1.1938	0.8944	0.2167
7	0.85	1.0692	1.2012	0.9220	0.2182
8	0.90	1.0792	1.2125	0.9487	0.2240
9	0.95	1.0910	1.2257	0.9747	0.2316
10	1.00	1.1014	1.2371	1.0000	0.2371

Table 3: The $\eta/\eta_\circ$ variation with concentration of Iso-butanol at 289.15K

S.No.	Concentration (mol.dm^{-3})	η (cp)	$\eta/\eta_\circ$	√C	$(\eta/\eta_\circ-1)/\sqrt{C}$
1	0.55	1.0039	1.1279	0.7416	0.1725
2	0.60	1.0140	1.1392	0.7746	0.1797
3	0.65	1.0318	1.1592	0.8062	0.1975
4	0.70	1.0420	1.1706	0.8367	0.2039
5	0.75	1.0518	1.1817	0.8660	0.2098
6	0.80	1.0701	1.2022	0.8944	0.2261
7	0.85	1.0801	1.2135	0.9220	0.2316
8	0.90	1.0989	1.2346	0.9487	0.2479
9	0.95	1.1088	1.2457	0.9747	0.2521
10	1.00	1.1267	1.2658	1.0000	0.2658

Table 4: The $\eta/\eta_\circ$ variation with concentration of Tert-butanol at temperature 289.15K

S.No.	Concentration (mol.dm^{-3})	η (cp)	$\eta/\eta_\circ$	√C	$(\eta/\eta_\circ-1)/\sqrt{C}$
1	0.55	1.0157	1.1411	0.7416	0.1903
2	0.60	1.0256	1.1522	0.7746	0.1965
3	0.65	1.0435	1.1723	0.8062	0.2137
4	0.70	1.0537	1.1838	0.8367	0.2196
5	0.75	1.0734	1.2059	0.8660	0.2378
6	0.80	1.0840	1.2178	0.8944	0.2435
7	0.85	1.1027	1.2389	0.9220	0.2591
8	0.90	1.1127	1.2501	0.9487	0.2636
9	0.95	1.1236	1.2623	0.9747	0.2692
10	1.00	1.1336	1.2736	1.0000	0.2736

The gotten $\eta/\eta_\circ$ magnitudes have been used for determining intermolecular interacting activities in aqueous solutions based on Jones-Dole equation:

$$(\eta/\eta_\circ-1)/\sqrt{C} = A+B\sqrt{C} \quad \text{.......... (1)}$$

where $\eta/\eta_\circ$ is relative viscosity, η is solution viscosity, $\eta_\circ$ is solvent viscosity, A is constant (A-coefficient) which stands for measure of solute-solute interaction, and B is constant (B-coefficient)
which represents a measure of solute-solvent interaction [21].

A and B magnitudes have gotten based on the slope and intercept of linear plots by $(\eta/\eta_\circ-1)/\sqrt{C}$

vs. √C. The gotten plots for alcohols have given in Figs 1 and 2 respectively.
The A value specifies the ion-ion interactions and it has been practically negative value for alcohols. Such this A value has been gotten in non-ionic aqueous solution. Therefore, the (A√C) term in Eq.1 can be ignored and eliminated

from Jones-Dole equation as employed for alcohols:

$$\eta/\eta_\circ = BC+1 \;\ldots\ldots\ldots\; (2)$$

The ($\eta/\eta_\circ$) plot vs. (C) must be linear with a slope value equivalent to B-coefficient. The applicability of Eq. 2 can be considered for non-electrolyte [22].

For alcohols, investigational data were employed to compute the (B) value from the plot ($\eta/\eta_\circ$) vs. (C). The obtained plot for alcohols is depicted in Fig (2). It is clear from the experimentations in this paper that the results validate the reduced Jone-Dole applicability based on Eq. 2.

In the analysis, the B values are (0.2180, 0.2616, 0.3046 and 0.3066 $mol.dm^{-3}$) for 1-butanol, sec-butanol, iso-butanol and tert-butanol respectively. They obviously have given suggestion for non-electrolytes reduced Jones-Dole equation that is feasibly exploited for measuring solute-solvent interactions. This stands for an auxiliary support of the structure promoting nature of solute in addition to the existence of H-H bonding, making capability and amphiphilic nature for interacting water molecules and alcohols.

In this paper, a positive magnitude of B specifies a robust arrangement of water molecules with alcohols that discloses the structure nature of 1-butanol, sec-butanol, iso-butanol and tert-butanol in aqueous solutions. The B-coefficients have been also identified as the introduced measure of order or disorder in the solvent structure through the solutes.

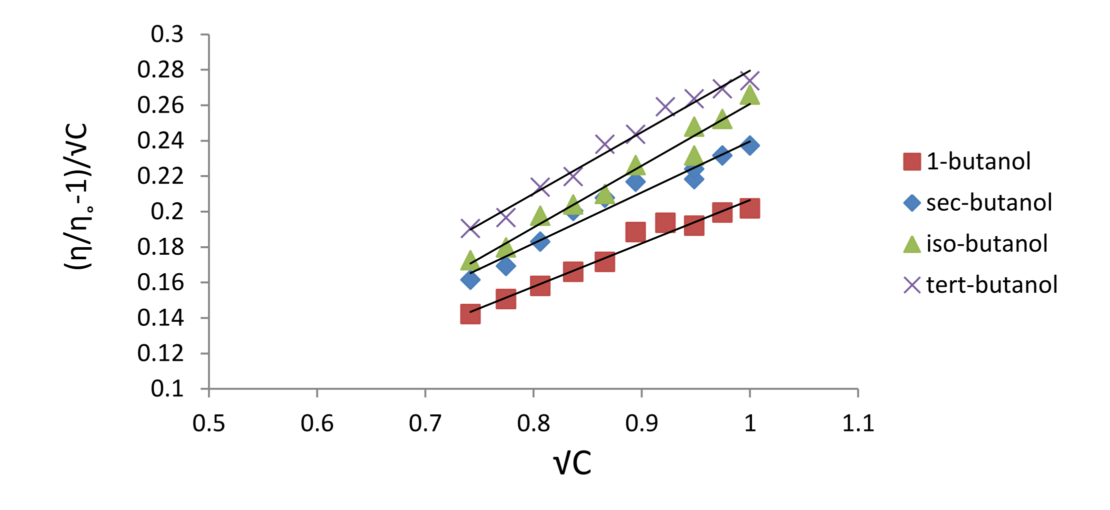

Fig.1: Plot ($\eta/\eta_\circ$-1)/$\sqrt{C}$ versus ($\sqrt{C}$) for butanol isomers at 298.15 K

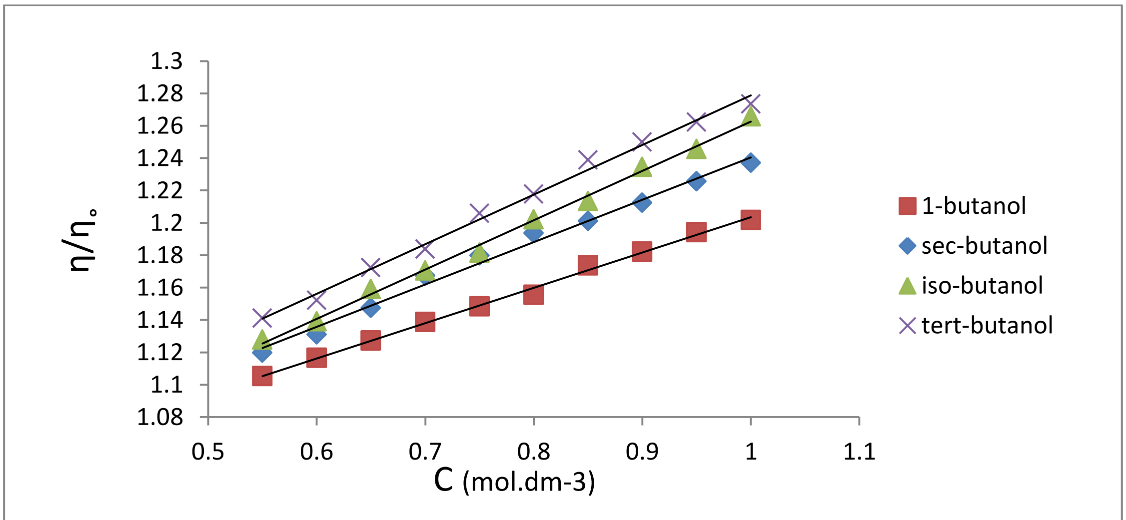

Fig.2: Plot ($\eta/\eta_\circ$ versus (C) for butanol isomers at 298.15 K

CONCLUSION

The viscometric study on 1-butanol, sec-butanol, iso-butanol and tert-butanol in aqueous solution has indicated the existence of solute-solvent interactions. It also asserts the robust hydrogen bonding capacity of all alcohols in water. On the

basis of study, it can be concluded that thereduced from of Jones-Dole equation is applicable for non-polar solutes. The positive and nearly equal value of B-coefficient for alcohols suggest that the study of viscometric relation used in the study may be a model for non-electrolyte solute in the field of solution chemistry.

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